Intraoral Scanning Systems: Purchase Decisions and System Overview

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RUNNING TITLE

Intraoral Scanning Systems

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INTRODUCTION

Do you already scan, or do you (still) take conventional impressions? Even if the advantages of the digital intraoral impression might be more obvious than ever for the dental user, the decision for the "correct" intraoral impression system is becoming increasingly difficult. In view of the ever-growing range of intraoral scanning systems, the user rightly wonders what is the best intraoral scanning system for me? What aspects do I need to consider when making a purchase? Can I really believe the promises of the dental industry?

This article is intended to provide a decision-making aid when entering the field of digital impression taking with intraoral scanning systems. In addition to the most important questions that the dental user should ask before a possible purchase, all relevant intraoral scanning systems currently available on the market are presented.

DECISIONS

Powder vs. Powder free

In principle, powder systems do not necessarily produce poorer results. The process of powdering the tooth surface is, however, an often cumbersome process. Especially for full arch impressions, powdering is rather cumbersome and involves complicated soft tissue management. If implants are to be imprinted intraorally using an intraoral scanner, no path leads past a powder-free scanning system. Furthermore, it should be noted that powder systems do not allow for a color representation of the scanned areas, but only monochrome representations.

Single image vs. Video sequence

In addition to the necessity of conditioning the tooth surface with powder, the imaging mode using single images or continuous video sequence is another criterion for the classification of intraoral scanners. It must be noted that the video mode is basically nothing more than a "faster" recording of single images. The CEREC Omnicam, for example, produces 18 individual images per second, enabling a recording speed of up to 6 cm per second. Nevertheless, it is important to note that single image systems, e.g. quadrant scans have a higher recording speed. However, a video sequence system is certainly more advantageous

in handling for full arch scans. However, a video sequence also presents a greater challenge to the accuracy, since several individual images must be matched correctly.

Monochrome vs. Real colors

It is obvious that the trend in intraoral scanning systems is clearly in the direction of true color representation. By means of such a color representation, valuable additional information, e.g. gingival differentiations, tooth discolorations, etc., can be used in the context of patient communication. First intraoral scanning system that allows tooth color determination directly at the digital scan, e.g. with the 3 Shape Trios3 intraoral scanner are already available and thus enable an objective and also quick determination of the correct tooth color restoration.

Open vs. Closed system

With CAD / CAM systems in general, it is essential to differentiate between open and closed systems. An open CAD / CAM system is characterized by the fact that the digital data records generated by the respective interface in the CAD / CAM process can also be read and used by programs of other manufacturers. The so-called STL file format (standard tesselation language) serves as a basis for this. The STL format describes the surface of a 3D body as composed of triangles of different sizes. Many manufacturers "encode" the STL files, however, into other formats and thus make the files compatible only for software-specific software solutions. Although a closed system means a certain system binding, the interfaces are adapted to the individual steps and coordinated with one another. This is not the case with open system solutions. It should also be noted in principle that the digitization using intraoralscanner is only the first process step within the CAD / CAM process. Further interfaces result from the CAD and CAM areas. These interfaces must thus actually also be taken into account when deciding for an intraoral scanning system.

Accuracy

The terms precision and trueness together determine the accuracy of an intraoral scanning system. Studies show that the accuracy of intraoral scanning systems can no longer be questioned [1, 2]. It is important for the user to distinguish between so-called in-vitro methods, i.e. on the model or in vivo methods, i.e. on the patient. It is easy to understand

that a scan on the patient is generally more difficult to perform than on a perfect, idealized demo model. As our own studies show, there are also large differences in accuracy depending on the detected scanning range [3, 4]. A quadrant scan is basically more accurate than a full-arch scan. It is also important for the user that software updates are often an improvement in accuracy because better algorithms are used during recording and modeling. This is the reason why little established intraoral impression systems have to be judged with caution precisely in terms of accuracy.

Indications of the digital workflow

An important decision when entering the process of digital impression taking is the definition of the indications to be covered by the digital workflow. It is basically a division into the fields of chairside, labside, implantology and orthodontics. Not every intraoral scanning system covers every area equally well. Thus, there are currently only a few chairside systems on the market, i.e.. systems in which the treatment can be performed in one single treatment session. The majority of the available intraoral scanning systems are based on the so-called labside workflow. This means the data sending of the digitally recorded data to a laboratory. The following overview of intraoral scanning systems provides a comprehensive overview of the respective indications for each of the respective intraoral scanning systems.

Possibility of digital data file diffusion

As already mentioned several times, the digital impression is much more than just the detection of the tooth surface. Special CAD / CAM solutions already enable the direct processing of the digital acquired data with other digital systems, such as the CBCT. However, for this purpose, the scanning system must be compatible with the other digital component. Due to the possibility of digital file fusion, highly promising options such as the purely digitally planned, fully navigated implantation with CAD / CAM-made drilling templates can be performed. In the future, such backward planning approaches are certainly also possible in the area of orthodontics, for example, to carry out tooth movements foreseeable, taking into account the particular bone offer.

Learning curve

The handling of the intraoral scanning system is certainly a decisive factor for many users. The intraoral scanning systems show significant differences. In particular, the size of the scanning head makes it easier or more difficult to perform the intraoral impression in some cases. The implementation of the digital impression, however, always follows a very shallow learning curve for each system and must be trained accordingly. Studies also show that the accuracy of the intraoral scan depends on so-called scan paths, i.e. the scanner should not be guided over the tooth surface in any way but according to a certain pattern [5]. It is therefore understandable that the current trend in development is aimed at simplifying the process of digital imaging. So-called "guided-scanning" procedures and colored scanning feedback messages to the user during the scanning process are first steps in this direction.

Price

The (still) high system price for intraoral scanning systems often presents a hurdle and an important decision-making base. However, an increasing competitive pressure for already established manufacturers is already observable. It should be noted that in addition to the one-time investment costs for the scanning system, depending on the manufacturer, other cost factors such as e.g. scan fees and license fees for software or updates may be possible.

OVERVIEW INTRAORAL SCANSYSTEMS

The following is an overview of the relevant intraoral scanning systems currently available on the market. There is no claim to completeness, the listing of the scanners is in alphabetical order of the manufacturers. In addition to the fundamental digital workflow, the intraoral scanning systems are also considered with regard to the already mentioned application areas chairside, labside, implantology and orthodontics. For the field of implantology, the aspects of prosthetic reconstruction and implant planning are considered; in the field of orthodontics the aspects of treatment planning and appliance design are considered.

3M ESPE - True Definition Scanner

The True Definition scanner has been available since the year 2014 on the German market. The recording principle is the so-called Active Wavefront Sampling, a further development of the principle of stereovision measurement. Due to the recording mode, the intraoralscanner

requires the powdering of the surface. The generated 3D data are monochrome. The intraoralscanner is available as a cart version with touch screen and will be available as a table version. Digital workflow is provided through the company's Cloud Platform 3M Connection Center. In the area of implantology, both implant planning and the prosthetic treatment of implants for manufacturers Straumann and Biomet are officially established as workflow. In the field of orthodontics there are interfaces to 3M Unitek for Incognito therapy and Align Technology for Invisalign therapy.
FIGURE 1

3SHAPE - Trios3
The Trios3 intraoralscanner has been available since the end of 2015 on the German market in addition to the predecessor versions Trios Standard (monochrome) and Trios Color (true colors). A new monochrome version of the Trios3 will be available soon. As with the predecessors Trios Standard and Color, the recording principle is confocal microscopy. The intraoralscanner works powder-free and in real colors and is available as a USB variant, as a cart variant with touch screen and as a variant integrated into the treatment unit. The digital workflow takes place via the Cloud platform 3Shape Trios Inbox. In the area of implantology, a special CAD software for implant planning and supply is available for various system solutions (3Shape Implantstudio). In the field of orthodontics, separate software solutions (3Shape Orthostudio and Appliance Designer) are also available.
FIGURE 2

ALIGN TECHNOLOGY - iTero element
The iTero element Intraoralscanner has been available on the German market since the end of 2015 and is the successor to the famous iTero scanner. The imaging principle is based on the principle of confocal microscopy and has been formerly restricted to monochromatic images. The recording does not require powdering of the tooth surface. The iTero element is available as a cart version and as a tabletop with touch screen. The digital workflow always takes place via the cloud platform MyAligntech. The focus of the digital workflow is, of course, in the field of orthodontics with an official interface to Invisalign. In the field of implantology, there is an official workflow with Straumann.
FIGURE 3

CARESTREAM - CS3600

The CS3600 intraoralscanner was first introduced as its predecessor CD3500 in 2013 and uses the recording principle of active triangulation with true color rendering. The scanner is powder free and is available as a USB variant and integrated into the treatment unit. Digital workflow takes place via the CS Connect cloud platform. In addition, a chairside workflow is also possible thanks to an interface to a compact CS3000 grinding machine. In the field of orthodontics there is a software solution for model analysis (CS model). Own concepts for implant planning and care are currently under development. As a special feature, the CS3600 intraoralscanner has a scanfeedback with a special color indication system during the scanning process.

FIGURE 4

DENTALWINGS - dwio

The dwio intraoralscanner is a further development of the Steinbichler DigImprint intraoralscanner and has been available since the end of 2015. The intraoralscanner is only available as a Cart variant and works powder-free and monochrome. The digital workflow is done via the DWOS Connect cloud platform. Own software solutions for the implant workflow (planning software coDiagnostiX) and the orthodontic workflow (model analysis software DWOS Orthodontic) are partly established. A special feature is the non-contact menu control by means of so-called "motion capturing" and a scanfeedback by means of a color indication system.

FIGURE 5

GC - AADVA

The AADVA intraoralscanner is a further development of the intraoralscanner a.tron 3D bluescan-I, presented a few years ago. The imaging principle is confocal microscopy. The intraoralscanner is exclusively available as a Cart variant and works powder-free and (still) monochrome. Digital workflow runs through its own cloud platform AADVA Connect. Own workflows for implantology and orthodontics are not established.

FIGURE 6

KAVO - Lythos

The Lythos intraoralscanner is a further development of Ormco's intraoral scanner. While the Ormco Lythos scanner is oriented towards a more orthodontic target group and only allows monochrome full-arch scans, the KaVo Lythos scanner is also able to record true color scans from smaller tooth areas. The recording principle is based on the principle of triangulation. The intraoralscanner is only available as a tabletop version. In addition to a chairside workflow with interfaces to own grinding machines, a labside workflow is provided by means of data transmission via its own cloud platform. Own workflows for implantology and orthodontics are not established.

FIGURE 7

PLANMECA - PlanScan

Originally distributed exclusively in the USA by E4D, the intraoralscanner Planscan has also been available in Europe for several years. The PlanScan intraoralscanner works powder-free in real colors according to the principle of active triangulation. The intraoralscanner is available as a USB variant and as a variant integrated into the treatment unit. The intraoralscanner allows to have a chairside workflow using the existing compact PlanMill 40 grinding machine. The labside workflow is established using the Planmeca Romexis Cloud platform. Own workflows for implantology and orthodontics are not established.

FIGURE 8

DENTPLY SIRONA - CEREC Omnicam

In addition to the CEREC Bluecam (powdered, monochrome, single images) and Apollo DI (powdered, monochrome, video sequence) offered by Dentsply Sirona, CEREC Omnicam is the latest intraoralscanner and has been available since 2013. The intraoralscanner works powder-free in real colors according to the principle of active triangulation. The CEREC Omnicam is available as a cart variant, USB variant and as a variant integrated into the treatment unit. The Sirona Connect cloud platform is connected to the labside workflow. The chairside workflow is established, as are interfaces to own implant planning and supply variants. For the area of orthodontics there is a separate software solution for the full-arch impression taking using a special "guided-scanning" procedure.

FIGURE 9

CONCLUSION

Never before has the range of intraoral scanning systems been greater. In view of the increasing availability of intraoral scanning systems, however, the decision for the "right" system is becoming increasingly difficult. At the same time, many obstacles still seem to be taking place until the digital intraoral impression becomes an indispensable component in dental practices. The indication extension of the intraoral scanning systems, i.e. the extension of the possibilities offered by the digital workflow is an important component. It is unquestionable that in the future, a significant increase in the indications is to be expected by an enhanced integration of digital imaging into diagnostic and therapeutic concepts. This extension of the indications will certainly lead to a further spread of the intraoral scanning systems. It is therefore unquestionable whether the digital intraoral impression can and will replace the conventional workflow. For the dental user, the question now arises as to when an entry into the digital workflow is useful for him, his practice concept and his team. The present article will provide valuable support in this decision-making process.

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